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August 27, 1971

PROPOSED AMENDMENTS TO 10 CFR PART 100, SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS

Note by the Secretary

The Director of Regulation has requested that the attached report by the Director of Reactor Standards be circulated for consideration by the Commission at the Policy Session scheduled for [illegible], September [illegible], 1971.

W. B. McCool

Secretary of the Commission

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ATOMIC ENERGY COMMISSION

PROPOSED AMENDMENT TO 10 CFR PART 100
SEISMIC AND GEOLOGIC SITING CRITERIA FOR
NUCLEAR POWER PLANTS

Report to the Director of Regulation
by the
Director, Division of Reactor Standards

THE PROBLEM

1. To consider the publication for public comment of proposed amendments to 10 CFR Part 100, "Reactor Site Criteria" which would add an Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." The purpose of the proposed amendments is to set forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants, and the suitability of the plant design bases established in consideration of the seismic and geologic characteristics of the proposed sites. These criteria also describe the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and to provide reasonable assurance that the nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public.

BACKGROUND AND SUMMARY

2. Subparagraph 50.34(a)(1) of 10 CFR Part 50 requires that applicants for a construction permit include in the preliminary safety analysis report a description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design. This subparagraph states that attention should be directed to the site evaluation factors identified in 10 CFR Part 100. Section 100.10 of 10 CFR Part 100 states that the Commission will take the physical characteristics of the site, including geology and seismology, into consideration in determining the acceptability of a site for a nuclear power plant.

3. The "Seismic and Geologic Siting Criteria for Nuclear Power Plants" have been prepared to assist applicants for construction permits by describing

the seismic and geologic characteristics of the site which need be determined in order to evaluate site suitability. The criteria describe procedures for determining the quantitative vibratory ground motion design basis at a site due to earthquakes and describe information needed to determine whether and to what extent a nuclear power plant need be designed for surface faulting. Other geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants, such as seismically-induced floods and water waves and soil stability, are also identified.

4. The criteria were prepared by the regulatory staff in cooperation with the United States Geological Survey and the National Oceanic and Atmospheric Administration. The development of these criteria has taken into account the experience accumulated to date in evaluating seismic and geologic characteristics of sites which have been proposed for the location of nuclear power plants. After having been reviewed extensively by the Advisory Committee on Reactor Safeguards, by the Division of Reactor Development and Technology, and by consultants of the Commission, an earlier draft of the criteria, dated March 19, 1969, was made available to selected representative utilities, both private and public, in order to obtain their comments regarding the proposed criteria. In view of the complexity of the subject matter addressed by the criteria and wide variations in site characteristics, it was considered desirable to obtain utility industry comments prior to publishing the criteria in the Federal Register for public comment in order to assure clarity of the criteria and their applicability to sites being considered by the utility industry. Commencing with an Industry Advisory Conference on July 8, 1969, and ending with the receipt of their coordinated written comments on June 10, 1970, utility views and those of their specialist consultants were obtained and carefully considered in revising the criteria. Many of the suggestions by the industry representatives have been incorporated into the revised criteria.

STAFF JUDGMENTS

5. The Divisions of Reactor Licensing, Operational Safety, Reactor Development and Technology, and the Office of the General Counsel concur in the recommendations of this paper. The Division of Operational Safety, in concurring in the recommendations of this paper, has made the following comment: "The Divisions under the General Manager wish to point out in concurring that recently proposed amendments to 10 CFR Part 70 (SECY-R-188)* require the siting principles of 10 CFR Part 100 to be applied to certain types of facilities other than reactors. The criteria here, which have been specifically developed for nuclear power plants, are thus likely to be applied to these non-reactor licensed facilities, and, in the interest of comparability, to similar Commission owned facilities. As these criteria may not be completely appropriate for such facilities, it is important that continuing recognition be given to the need to make reasonable judgments on their implementation." The ACRS has reviewed and concurs in the publication of the proposed criteria. The draft public announcement was prepared by the Division of Public Information. The Office of Congressional Relations concurs in the draft letter to the Joint Committee on Atomic Energy.

RECOMMENDATION

6. The Director of Regulation recommends that the Atomic Energy Commission

a. Approve publication of proposed amendments to 10 CFR Part 100 "Reactor Site Criteria" adding an Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants" allowing [illegible] days for public comment. The purpose of the proposed amendments is to set forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants, and the suitability of the plant design bases established in consideration of the seismic and geologic characteristics of the proposed sites;

b. Note that the Advisory Committee on Reactor Safeguards concurs in publishing the proposed amendments to Part 100 for comment;

c. Note that, if after expiration of the comment period no adverse comments or significant questions have been received and no substantial changes in the text of the rule are indicated, the Director of Regulation will arrange for publication of the amendments in final form. If adverse comments or significant questions have been received or substantial changes in the text of the rule are indicated, the revised amendment will be submitted to the Commission for approval.

*Secretariat Note: [illegible] Proposed Amendments to Part [illegible] Review of Plutonium and Fuel Fabrication Plants, approved at [illegible] Meeting [illegible] April [illegible]

d. Note that the Joint Committee on Atomic Energy will be informed by letter such as Appendix "B"; and

e. Note that a public announcement such as Appendix "C" will be issued on filing of the notice with the Federal Register.

LIST OF ENCLOSURES

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APPENDIX "A"

ATOMIC ENERGY COMMISSION

[10 CFR Part 100]

Seismic and Geologic Siting Criteria for Nuclear Power Plants

The Atomic Energy Commission has under consideration amendments to its regulations, 10 CFR Part 100, "Reactor Site Criteria," which would add an Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." The purpose of the criteria is to set forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants and the suitability of the plant design bases established in consideration of the seismic and geologic characteristics of the proposed sites in order to provide reasonable assurance that the nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public.

The criteria describe the seismic and geologic investigations required to obtain information needed to determine the design basis for earthquake-produced vibratory ground motion and for seismically-induced floods and water waves. They also describe investigations required to obtain information to determine whether and to what extent the nuclear power plant need be designed for surface faulting.

The design basis for the maximum vibratory ground motion is determined, as described in the criteria, through evaluation of the geology and the geologic and seismic history of the site and the surrounding region. The most severe earthquakes associated with tectonic structures or tectonic provinces in the region surrounding the site are identified by considering those historically reported earthquakes that can be associated with these structures or provinces. If faults in the region surrounding the site are active faults, the most severe expected earthquakes associated with these faults are determined by also considering their geologic history. Because of the limited historical data, the most severe earthquakes associated with these tectonic structures or tectonic provinces are determined in a conservative manner and are usually larger than the maximum earthquakes historically recorded. The design basis for vibratory ground motion at the site is then determined by assuming that the epicenters or regions of highest intensity of the earthquakes are situated at the point on the tectonic structures or tectonic provinces nearest the site.

The criteria require the evaluation of other design considerations which are affected by the design basis for vibratory ground motion, including soil stability, slope stability, and cooling water supply.

In order to determine whether and to what extent a nuclear power plant need be designed to withstand the effects of surface faulting, the criteria require that the location of the site with respect to active faults be considered. Procedures are provided for determining whether the site is within a zone requiring detailed faulting investigation based on its location with respect to active faults. Where a site is within a zone requiring detailed faulting investigation, the criteria require that the regional and local geologic and seismic characteristics of the site be investigated in considerable detail. The adequacy of the detailed investigation will be determined by the Commission on an individual case basis, taking into account the specific site characteristics. Where the detailed investigation indicates that surface faulting need not be taken into account in the design of the nuclear power plant, the criteria require that sufficient data to clearly justify the proposed design basis be presented in the license application.

The criteria also provide general guidance for the design of a nuclear power plant to withstand earthquake-caused effects, pending the development of more detailed criteria.

The criteria were prepared in cooperation with the United States Geological Survey and the National Oceanic and Atmospheric Administration. The development of these criteria has taken into account the experience accumulated by these agencies and the Atomic Energy Commission in evaluating seismic and geologic characteristics of sites which have been proposed to date for the location of nuclear power plants. The development of these criteria has also taken into account discussions with and comments by a representative group of utilities and their specialist consultants in order to assure clarity of the criteria and their applicability to sites being considered by the nuclear industry.

These seismic and geologic siting criteria would supplement 10 CFR Part 100 by specifying the seismic and geologic investigations and analyses necessary in determining the acceptability of a proposed site, as required by §100.10 of 10 CFR Part 100. Specific reference to the proposed Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," would be added to §100.10(c)(1). The provisions in §100.10(c)(1) which state that the design of a facility should conform to accepted building codes or standards and that no facility should be located closer than one-fourth mile from the surface location of a known active earthquake fault would be retained since these provisions are superseded by these criteria.

The criteria would also assist applicants in connection with §50.34(a)(1) of 10 CFR Part 50 which requires that the preliminary

safety analysis report include a description and safety assessment of the site on which a production or utilization facility is to be located, with appropriate attention to features affecting facility design.

The Commission expects that the provisions of the proposed amendments will be useful as interim guidance until such time as the Commission takes further action on them.

Pursuant to the Atomic Energy Act of 1954, as amended, and section 553 of Title 5 of the United States code, notice is hereby given that adoption of the following amendments to 10 CFR Part 100 is contemplated. All interested persons who wish to submit comments or suggestions in connection with the proposed amendments should send them to the Secretary, United States Atomic Energy Commission, Washington, D. C. 20545, Attention: Chief, Public Proceedings Branch, within 60 days after publication of this notice in the FEDERAL REGISTER. Copies of comments received may be examined in the Commission's Public Document Room at 1717 H Street, N. W., Washington, D. C.

1. In §100.10, paragraph (c)(1) is amended to read as follows:

§100.10 Factors to be considered when evaluating sites.

(c) Physical characteristics of the site, including seismology, meteorology, geology and hydrology.

(1) Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants" sets forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants.

2. A new Appendix A is added to read as follows:

Appendix "A"

APPENDIX A

SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS

I. PURPOSE

It is the purpose of these criteria to set forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants, and the suitability of the plant design bases established in consideration of the seismic and geologic characteristics of the proposed sites.

These criteria are based on the limited geophysical and geological information available to date concerning earthquake occurrence and effect. They will be revised as necessary when more complete information becomes available.

II. SCOPE

These criteria, which apply to nuclear power plants, describe the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and provide reasonable assurance that a nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public. They describe procedures for determining the quantitative vibratory ground motion design basis at a site due to earthquakes and describe information needed to determine whether and to what extent a nuclear power plant need be designed for surface faulting. Other geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants are identified.

Each applicant for a construction permit shall investigate all seismic and geologic factors that may affect the design and operation of the proposed nuclear power plant irrespective of whether such factors are explicitly included in these criteria. Additional investigations and more conservative determinations than those included in these criteria may be required for sites located in unusual geologic or seismic areas. If an applicant believes that the seismology and geology of a site indicate that some of these criteria, or portions thereof, need not be satisfied, the specific sections of these criteria should be identified in the license application, and supporting data to justify clearly such departures should be presented.

III. DEFINITIONS

As used in these criteria:

(a) The "magnitude" of an earthquake is a measure of the size of an earthquake and is related to the energy released in the form of seismic waves. "Magnitude" means the numerical value on a Richter scale.

(b) The "intensity" of an earthquake is a measure of its effects on man, on man-built structures, and on the earth's surface at a particular location. "Intensity" means the numerical value on the Modified Mercalli scale.

(c) The "Safe Shutdown Earthquake" is that earthquake which produces the vibratory ground motion for which structures, systems, and components important to safety are designed to remain functional.

These structures, systems, and components are those necessary to assure:

(1) the integrity of the reactor coolant pressure boundary,

(2) the capability to shut down the reactor and maintain it in a safe shutdown condition, or

(3) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of 10 CFR Part 100.

(d) The "Operating Basis Earthquake" is that earthquake which produces the vibratory ground motion for which those structures, systems, and components necessary for power generation are designed to remain operable.

(e) A "fault" is a tectonic structure along which differential displacement of the adjacent earth materials has occurred parallel to the fracture plane. It is distinct from nontectonic types of ground disruption such as landsliding, fissuring, and cratering. A fault may have gouge or breccia between its two walls and includes any associated monoclinal flexure (a steplike bend in otherwise horizontal or gently dipping beds which passes into a fault) or other similar geologic structural feature.

(f) "Surface Faulting" is differential ground displacement at or near the surface caused directly by fault movement and is distinct from nontectonic types of ground disruption, such as landsliding, fissuring, and cratering.

(g) An "active fault"* is a fault which has exhibited one or more of the following characteristics:

(1) Movement at or near the ground surface at least once in the past 35,000 years or more than once in the past 500,000 years. In the absence of data permitting absolute dating, faults with sufficiently recent movement to leave perceptible evidence of surface rupture, surface warping, or offset of geomorphic features are considered active faults.

(2) Instrumentally well-determined macro-seismicity for a fault located in the continental United States west of the Rocky Mountain Front, or in Alaska, Hawaii, or Puerto Rico.

(3) A relationship to an active fault according to characteristics (1) or (2) such that movement on one could be reasonably expected to be accompanied by movement on the other.

In some cases, the geologic evidence of past activity at or near the ground surface along a particular fault may be obscured at a particular site. This might occur, for example, at a site having a deep alluvial overburden. For these cases, evidence may

* The definition and use of "active fault" in these criteria is not the same as other definitions generally used by geologists. An active fault is a fault whose geologic history shall be taken into account in evaluating the fault's potential for causing vibratory ground motion or surface faulting. The historic seismicity of a fault shall be taken into account in determining the design basis for vibratory ground motion even though the fault is not considered to be an active fault by these criteria.

exist elsewhere along the fault from which an evaluation of its characteristics in the vicinity of the site can be reasonably based. Such evidence shall be used in determining whether the fault is an active fault within this definition.

Other valid geologic reasons may exist to demonstrate that a fault which has one of the characteristics stated in (1) through (3) is not an active fault within this definition. For example, some faults may lack deep-seated, long-term causes and be due to shallow short-term causes. Association of a fault with geologic structural features which are geologically old (at least pre-Quaternary) may, in the absence of conflicting evidence, demonstrate that the fault is not an active fault within this definition.

(h) A "tectonic province" is a region of the North American continent characterized by a uniformity of the geologic structural features contained therein.

(i) A "tectonic structure" is a large scale dislocation or distortion within the earth's crust. Its extent is measured in miles.

(j) A "zone requiring detailed faulting investigation" is the zone within which a nuclear power reactor may be located only if a detailed investigation of the regional and local geologic and seismic characteristics of the site is made in order to consider the need to design for surface faulting.

(k) The "control width" of a fault is the maximum width of mapped fault traces, including all Quaternary fault traces which join or can reasonably be inferred to join the main fault trace, measured within 10 miles along the fault's trend in both directions from the point of nearest approach to the site. (See Figure 1)

(l) A "response spectrum" is a plot of the maximum peak responses of a family of idealized single-degree-of-freedom damped oscillators to a specified vibratory motion input at their supports.

IV. REQUIRED INVESTIGATIONS

The geologic, seismic, and engineering characteristics of a site and its environs shall be investigated in sufficient scope and detail to (1) provide reasonable assurance that they are sufficiently well understood to permit an adequate evaluation of the proposed site, and (2) provide sufficient information to support the determinations required by these criteria and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. The size of the region to be investigated and the type of data pertinent to the investigations shall be determined by the nature of the region surrounding the proposed site. The investigations shall be carried out by a review of the pertinent literature and/or field investigations and shall include the steps outlined in (a) through (c).

(a) Required Investigation for Vibratory Ground Motion. The purpose of the investigations required by this paragraph is to obtain information needed to describe the vibratory ground motion produced by the Safe Shutdown Earthquake. All of the steps in subparagraphs IV (a)(3) through IV (a)(8) need not be carried out if the Safe Shutdown Earthquake can be clearly established by investigations and determinations of a lesser scope. The investigations shall include the following:

(1) Determination of the lithologic, stratigraphic, and structural geologic conditions at the site and the region surrounding the site, including its geologic history.

(2) Identification of tectonic structures underlying the site and the region surrounding the site;

(3) Determination of physical evidence concerning behavior during prior earthquakes of the surficial geologic materials and the substrata underlying the site from the lithologic, stratigraphic, and structural geologic studies;

(4) Determination of the static and dynamic engineering properties of the materials underlying the site. Included should be properties needed to determine the behavior of the underlying material during earthquakes and the characteristics of the underlying material in transmitting earthquake-induced motions to the foundations of the plant, such as seismic wave velocities, density, water content, porosity, and strength.

(5) Listing of all historically reported earthquakes which have affected or which could be reasonably expected to have affected the site, including the date of occurrence and the following measured or estimated data: magnitude or highest intensity, and a plot of the epicenter or region of highest intensity. Where historically reported earthquakes could have caused a maximum ground acceleration of at least one-tenth the acceleration of gravity (0.1g) at the foundations of the proposed nuclear power plant structures, the acceleration or intensity and duration of ground shaking at these foundations shall also be estimated. Since earthquakes have been reported in terms of various parameters, such as magnitude, intensity at a given location, and effect on ground, structures, and people at a specific location, some of these data may have to be estimated by use of appropriate empirical relationships. Where appropriate, the comparative characteristics of the material underlying the epicentral location or region of highest intensity and of the material underlying the site in transmitting earthquake vibratory motion shall be considered.

(6) Correlation of epicenters or regions of highest intensity of historically reported earthquakes, where possible, with tectonic structures, any part of which is located within 200 miles of the site. Epicenters or regions of highest intensity which cannot be reasonably correlated with tectonic structures shall be identified with tectonic provinces, any part of which is located within 200 miles of the site.

(7) For faults, any part of which is within 200 miles* of the site and which may be of significance in establishing the Safe Shutdown Earthquake, determination of whether these faults are to be considered as active faults. This determination is required in order to permit appropriate consideration of the geologic history of such faults in establishing the Safe Shutdown Earthquake. For guidance in determining which faults may be of significance in determining the Safe Shutdown Earthquake, Table 1 presents the minimum length of fault to be considered versus distance from site. Active faults of lesser length than those indicated in Table 1 and faults which are not active faults generally need not be considered in determining the Safe Shutdown Earthquake, except where unusual circumstances indicate such consideration is appropriate.

Table 1

Distance from the site (miles)	Minimum length of fault (miles) to be considered in establishing Safe Shutdown Earthquake
0 to 20	1
greater than 20 to 50	5
greater than 50 to 100	10
greater than 100 to 150	20
greater than 150 to 200	40

* If the Safe Shutdown Earthquake can be associated with a fault closer than 200 miles to the site, the procedures of subparagraphs IV (a)(7) and IV (a)(c) need not be carried out for successively more remote faults.

(8) For faults, any part of which is within 200 miles* of the site which may be of significance in establishing the Safe Shutdown Earthquake and which are considered as active faults, determination of:

(i) The length of the fault;

(ii) The relationship of the fault to regional tectonic structures;

(iii) The nature, amount, and geologic history of displacements along the fault, including particularly the estimated amount of the maximum Quaternary displacement related to any one earthquake along the fault.

(b) Required Investigation for Surface Faulting. The purpose of the investigations required by this paragraph is to obtain information to determine whether and to what extent the nuclear power plant need be designed for surface faulting. If the design basis for surface faulting can be clearly established by investigations of a lesser scope, all of the steps in subparagraphs IV (b)(3) through IV (b)(6) need not be carried out. The investigations shall include the following:

(1) Determination of the lithologic, stratigraphic, and structural geologic conditions of the site and the area surrounding the site, including its geologic history;

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* If the Safe Shutdown Earthquake can be associated with a fault closer than 200 miles to the site, the procedures of subparagraphs IV (a)(7) and IV (a)(8) need not be carried out for successively more remote faults.

(2) Determination of geologic evidence of fault offset at or near the ground surface at or near the site;

(3) For faults greater than 1000 feet long, any part of which is within 5 miles* of the site, determination of whether these faults are to be considered as active faults;

(4) Listing of all historically reported earthquakes which can be reasonably associated with active faults greater than 1000 feet long, any part of which is within 5 miles* of the site, including the date of occurrence and the following measured or estimated data: magnitude or highest intensity, and a plot of the epicenter or region of highest intensity;

(5) Correlation of epicenters or regions of highest intensity of historically reported earthquakes with active faults greater than 1000 feet long, any part of which is located within 5 miles* of the site;

(6) For active faults greater than 1000 feet long, any part of which is within 5 miles* of the site, determination of:

(i) The length of the fault;

(ii) The relationship of the fault to regional tectonic structures;

(iii) The nature, amount, and geologic history of displacements along the fault, including particularly the estimated amount of the

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* If the design basis for surface faulting can be determined from a fault closer than 5 miles to the site, the procedures of subparagraphs IV (b)(3) through IV (b)(6) need not be carried out for successively more remote faults.

maximum Quaternary displacement related to any one earthquake along the fault;

(iv) The outer limits of the fault established by mapping Quaternary fault traces for 10 miles along its trend in both directions from the point of its nearest approach to the site.

(c) Required Investigation for Seismically-Induced Floods and Water Waves.

(1) For coastal sites, the investigations shall include the determination of:

(i) Information regarding distantly and locally generated waves or tsunami which have affected or could have affected the site. Available evidence regarding the run-up and draw-down associated with historic tsunami in the same coastal region as the site shall also be included.

(ii) Local features of coastal topography which might tend to modify tsunami run-up or draw-down. Appropriate available evidence regarding historic local modifications in tsunami run-up or draw-down at coastal locations having similar topography to the site shall also be obtained.

(iii) Appropriate geologic and seismic evidence to provide information for establishing the design basis for seismically-induced floods or water waves from a local offshore earthquake, from local offshore effects of an onshore earthquake, or from coastal subsidence. This evidence shall be determined, to the extent practical, by a procedure similar to that required in paragraphs IV (a) and

IV (b). The probable slip characteristics of offshore faults shall also be considered as well as the potential for offshore slides in submarine material.

(2) For sites located near lakes and rivers, investigations similar to those required in subparagraph (1) shall be carried out, as appropriate, to determine the potential for the nuclear power plant to be exposed to seismically-induced floods and water waves as, for example, from the failure during an earthquake of an upstream dam or from slides of earth or debris into a nearby lake.

V. SEISMIC AND GEOLOGIC DESIGN BASES

(a) Determination of Design Basis for Vibratory Ground Motion. The design of each nuclear power plant shall take into account the potential effects of vibratory ground motion caused by earthquakes. The design basis for the maximum vibratory ground motion is determined through evaluation of the geology and the geologic and seismic history of the site and the surrounding region. The most severe earthquakes associated with tectonic structures or tectonic provinces in the region surrounding the site are identified by considering those historically reported earthquakes that can be associated with these structures or provinces. If faults in the region surrounding the site are active faults, the most severe expected earthquakes associated with these faults are determined by also considering their geologic history. The vibratory ground motion at the site is then determined by assuming that the epicenters or regions of highest intensity of the earthquakes are situated at the point on

the tectonic structures or tectonic provinces nearest to the site. The earthquake which could cause the maximum vibratory ground motion at the site is designated the Safe Shutdown Earthquake. The specific procedures for determining the design basis for vibratory ground motion are given in the following sections.

(1) Determination of Safe Shutdown Earthquake. The Safe Shutdown Earthquake shall be identified through evaluation of seismic and geologic information developed pursuant to the requirements of paragraph IV (a), as follows:

(i) The historic earthquakes of greatest magnitude or intensity which have been correlated with tectonic structures pursuant to the requirements of subparagraph IV (a)(6) shall be determined. In addition, for active faults, information required by the paragraph IV (a)(8) shall also be taken into account in determining the earthquakes of greatest magnitude related to the faults. The magnitude or intensity of these earthquakes based on geologic evidence may be larger than that of the maximum earthquakes historically recorded. The accelerations at the site shall be determined assuming that the epicenters of the earthquakes of greatest magnitude or the regions of highest intensity related to the tectonic structures are situated at the point on the structures closest to the site.

(ii) Where epicenters or regions of highest intensity of historically reported earthquakes cannot be reasonably related to tectonic structures but are identified pursuant to the requirements

of subparagraph IV (a)(6) with tectonic provinces in which the site is located, the accelerations at the site shall be determined assuming that these earthquakes occur adjacent to the site.

(iii) Where epicenters or regions of highest intensity of historically reported earthquakes cannot be reasonably related to tectonic structures but are identified pursuant to the requirements of subparagraph IV (a)(6) with tectonic provinces in which the site is not located, the accelerations at the site shall be determined assuming that the epicenters or regions of highest intensity of these earthquakes are located at the closest point to the site on the boundary of the tectonic province.

(iv) The earthquake producing the maximum vibratory acceleration at the site, as determined from subdivisions (i) through (iii) shall be designated the Safe Shutdown Earthquake for vibratory ground motion, except as noted in subdivision (v). The characteristics of the Safe Shutdown Earthquake shall be derived from more than one earthquake, determined from subdivisions (i) through (iii) where necessary to assure that the maximum vibratory acceleration at the site throughout the frequency range of interest is included. In order to compensate for the limited data, the procedures in subdivisions (i) through (iii) should be applied in a conservative manner. The maximum vibratory accelerations of the Safe Shutdown Earthquake at the foundations of the nuclear power plant structures shall be determined taking into account the characteristics of the underlying soil material

in transmitting the earthquake-induced motions, obtained pursuant to subparagraphs IV (a)(1), (3), and (4). The Safe Shutdown Earthquake shall be defined by response spectra corresponding to the maximum vibratory accelerations as outlined in paragraph VI (a).

(v) Where the maximum vibratory accelerations of the Safe Shutdown Earthquake at the foundations of the nuclear power plant structures are determined to be less than one-tenth the acceleration of gravity (0.1g) as a result of the steps required in subdivisions (i) through (iv), it shall be assumed that the maximum vibratory accelerations of the Safe Shutdown Earthquake at these foundations are at least 0.1g.

(2) Determination of Operating Basis Earthquake. The Operating Basis Earthquake may be specified by the applicant. If vibratory ground motion occurs which produces a maximum acceleration above .05g at any foundation of the nuclear power plant structures or which exceeds that of the Operating Basis Earthquake, whichever is greater, shutdown of the nuclear power plant will be required. Prior to resuming operations, the licensee shall demonstrate to the Commission that no functional damage has occurred to features necessary for continued operation.

(b) Determination of Need to Design for Surface Faulting. In order to determine whether a nuclear power plant is required to be designed to withstand the effects of surface faulting, the location of the site with respect to active faults shall be considered. The area over which each of these faults has caused surface faulting

in the past is identified by mapping its fault traces in the vicinity of the site. The fault traces are mapped along the trend of the fault for 10 miles in both directions from the point of its nearest approach to the site because, for example, traces may be obscured along portions of the fault. The maximum width of the mapped fault traces, called the control width, is then determined from this map. Because surface faulting has sometimes occurred beyond the limit of mapped fault traces, or where fault traces have not been previously recognized, the control width of the fault is increased by a factor which is dependent upon the largest potential earthquake related to the fault. This larger width delineates a zone, called the zone requiring detailed faulting investigation, in which the possibility of surface faulting is to be considered. The following section outlines the specific procedures for determining the zone requiring detailed faulting investigation for an active fault.

(1) Determination of Zone Requiring Detailed Faulting Investigation. The zone requiring detailed faulting investigation for an active fault, which was investigated pursuant to the requirement of subparagraph IV (b)(6), shall be determined through use of the following table:

Table 2

Determination of Zone Requiring Detailed Faulting Investigation

Magnitude of Earthquake	Width of Zone Requiring Detailed Faulting Investigation (See Figure 1)
Less than 5.5	1 x control width
5.5 - 6.4	2 x control width
6.5 - 7.5	3 x control width
Greater than 7.5	4 x control width

The largest magnitude earthquake related to the fault shall be used in Table 2. This earthquake shall be determined from the information developed pursuant to the requirements of paragraph IV (b) for the fault, taking into account the information required by subparagraph IV (b)(6). The control width used in Table 2 is determined by mapping the outer limits of the fault traces from information developed pursuant to subdivision IV (b)(6)(iv). The control width shall be used in Table 2 unless the characteristics of the fault are obscured for a significant portion of the 10 miles on either side of the point of nearest approach to the site. In this event, the use in Table 2 of the width of the fault more than 10 miles from the point of nearest approach to the site may be appropriate.

The zone requiring detailed faulting investigation, as determined from Table 2, shall be used for the fault except where:

(i) The zone requiring detailed faulting investigation from Table 2 is less than one-half mile in width. In this case the zone shall be at least one-half mile in width.

(ii) Definitive evidence concerning the regional and local characteristics of the fault justifies use of a different value.

In delineating the zone requiring detailed faulting investigation for a fault, the center shall coincide with the center of the fault at its point of nearest approach to the site as illustrated in Figure 1.

(c) Determination of Design Bases for Seismically-Induced Floods and Water Waves. The size of seismically-induced floods and water waves which could affect a site shall be determined, taking into consideration the results of the investigation required by paragraph IV (c). Local topographic characteristics which might tend to modify the possible run-up and draw-down at the site shall be considered. Adverse tide conditions shall also be taken into account in determining the effect of the floods and waves on the site. The characteristics of the earthquake to be used in evaluating the offshore effects of local earthquakes shall be determined by a procedure similar to that used to determine the characteristics of the Safe Shutdown Earthquake in paragraph V (a).

(d) Determination of Other Design Conditions

(1) Soil Stability. Vibratory ground motion associated with the Safe Shutdown Earthquake can cause soil instability due to ground disruption, such as fissuring, differential consolidation, and cratering, which is not directly related to surface faulting. The following geologic features which could affect the formations

of the proposed nuclear power plant structures shall be evaluated, taking into account the information concerning physical properties of materials underlying the site developed pursuant to subparagraphs IV (a)(1), (3), and (4) and the effects of the Safe Shutdown Earthquake:

(i) Areas of actual or potential surface or subsurface subsidence, uplift, or collapse resulting from:

(a) Natural features such as tectonic depressions and cavernous or karst terrains, particularly those underlain by calcareous or other soluble deposits:

(b) Man's activities, such as withdrawal or addition of subsurface fluids, or mineral extraction;

(c) Regional warping.

(ii) Deformational zones, such as sheats, joints, fractures and folds, or combinations of these features.

(iii) Zones of alteration or irregular weathering profiles, and zones of structural weakness composed of crushed or disturbed materials.

(iv) Unrelieved residual stresses in bedrock.

(v) Rocks or soils that might be unstable because of their mineralogy, lack of consolidation, water content, or potentially undesirable response to seismic or other events. Seismic response characteristics to be considered shall include liquefaction, thixotropy, differential consolidation, cratering, and fissuring.

(2) Slope Stability. Stability of all slopes, both natural and artificial, the failure of which could adversely affect the nuclear power plant, shall be considered. An assessment shall be made of the potential effects of erosion or deposition, and of combinations of erosion or deposition with seismic activity, taking into account information concerning the physical properties of the materials underlying the site developed pursuant to subparagraphs IV (a)(1), (3), and (4) and the effects of the Safe Shutdown Earthquake.

(3) Cooling Water Supply. Assurance of adequate cooling water supply for emergency and long-term shutdown decay heat removal shall be considered in the design of the nuclear power plant, taking into account information concerning the physical properties of the materials underlying the site developed pursuant to subparagraphs IV (a)(1), (3), and (4) and the effects of the Safe Shutdown Earthquake and the design basis for surface faulting. Consideration of river blockage or diversion, coastal uplift or subsidence, or tsunami run-up and draw-down, and of the failure of dams and intake structures shall be included in the evaluation, where appropriate.

VI. ENGINEERING DESIGN CRITERIA

The engineering design criteria included in this section are intended only for general guidance. More detailed criteria for seismic design of nuclear power plants are being developed.

(a) Vibratory Ground Motion

(1) Safe Shutdown Earthquake. The vibratory ground motion produced by the Safe Shutdown Earthquake shall be defined by response spectra corresponding to the maximum vibratory accelerations at the elevations of the foundations of the nuclear power plant structures determined pursuant to subparagraph V (a)(1). The response spectra shall relate the response of the foundations of the nuclear power plant structures to the vibratory ground motion, considering such foundations to be single-degree-of-freedom damped oscillators and neglecting soil-structure interaction effects. In view of the limited data available on vibratory ground motions of strong earthquakes, it usually will be appropriate that the response spectra be smoothed design spectra, developed from an envelope of spectra related to the measured vibratory motions caused by more than one earthquake.

The nuclear power plant shall be designed so that, if the Safe Shutdown Earthquake occurs, all structures, systems, and components important to safety will remain functional. These structures, systems, and components are those necessary to assure 1) the integrity of the reactor coolant pressure boundary, 2) the capability to shut down the reactor and maintain it in a safe condition, or 3) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of this part.

In addition to seismic loads, including aftershocks, applicable concurrent functional and accident-induced loads shall be taken into account in the design of these safety-related structures, systems, and components. The design of the nuclear power plant shall also take into account the possible effects of the Safe Shutdown Earthquake on the facility foundations by ground disruption, such as fissuring, differential consolidation, cratering, liquefaction, and landsliding, as required in paragraph V (d).

The engineering method used to ensure that the required safety functions are maintained during and after the vibratory ground motion associated with the Safe Shutdown Earthquake shall involve the use of a suitable dynamic analysis, such as a time history method, except where it can be demonstrated that the use of an equivalent static load method provides adequate conservatism. The analysis shall take into account soil-structure interaction effects and the expected duration of vibratory motion. It is permissible to allow strain limits in excess of yield strain in some of these safety-related structures, systems, and components during the Safe Shutdown Earthquake and under the postulated concurrent conditions, provided that the necessary safety functions are maintained.

These safety-related structures, systems, and components shall also be designed to withstand the effects of vibratory motion of at least fifty percent of the Safe Shutdown Earthquake

in combination with other appropriate loads well within elastic limits.

(2) Operating Basis Earthquake. Where the applicant chooses to design the nuclear power plant to withstand the effects of an Operating Basis Earthquake, the Operating Basis Earthquake shall be defined by response spectra.

All structures, systems, and components of the nuclear power plant necessary for power generation shall be designed to withstand the effects of the vibratory motion of the Operating Basis Earthquake in combination with other appropriate loads well within elastic limits.

The engineering method used to ensure that all structures, systems, and components necessary for power generation are capable of withstanding the effects of the Operating Basis Earthquake shall involve the use of a suitable dynamic analysis, such as a time history method, except where it can be demonstrated that the use of an equivalent static load method provides adequate conservatism. The analysis shall take into account soil-structure interaction effects and the expected duration of vibratory motion.

(3) Required Seismic Instrumentation. Suitable instrumentation shall be provided so that the seismic response of nuclear power plant features important to safety can be determined promptly to permit comparison of such response with that used as the design basis. Such

a comparison is needed to decide whether the plant can continue to be operated safely and to permit such timely action as may be appropriate.

(b) Surface Faulting. If the reactor facility is to be located within the zone requiring detailed faulting investigation, a detailed investigation of the regional and local geologic and seismic characteristics of the site shall be carried out to determine the need to take into account surface faulting in the design of the nuclear power plant. Where it is determined that surface faulting need not be taken into account, sufficient data to clearly justify the determination shall be presented in the license application.

Where it is determined that surface faulting must be taken into account, guidance in establishing the design basis for surface faulting on a site shall be obtained from the data in Technical Information Document 24124, "Historic Surface Faulting in Continental United States and Adjacent Parts of Mexico," by M. G. Bonilla, U.S. Geological Survey, 1967, from the evidence concerning the regional and local geologic and seismic characteristics of the site, and from any other relevant data.

The design basis for surface faulting shall be taken into account in the design of the nuclear power plant by providing reasonable assurance that in the event of occurrence of such faulting all structures, systems, and components important to

safety will remain functional. These structures, systems, and components are those necessary to assure 1) the integrity of the reactor coolant pressure boundary, 2) the capability to shut down the reactor and maintain it in a safe shutdown condition, or 3) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of this part. In addition to seismic loads, including aftershocks, applicable concurrent functional and accident-induced loads shall be taken into account in the design of such safety features. The design provisions shall be based on an assumption that the design basis for surface faulting can occur in any direction and azimuth and under any part of the nuclear power plant, unless evidence indicates this assumption is not appropriate, and shall take into account the estimated rate at which the surface faulting may occur.

(c) Seismically-Induced Floods and Water Waves and Other Design Conditions. The design basis for seismically-induced floods and water waves and other design conditions determined pursuant to paragraphs V (c) and (d), shall be taken into account in the design of the nuclear power plant so as to prevent undue risk to the health and safety of the public.

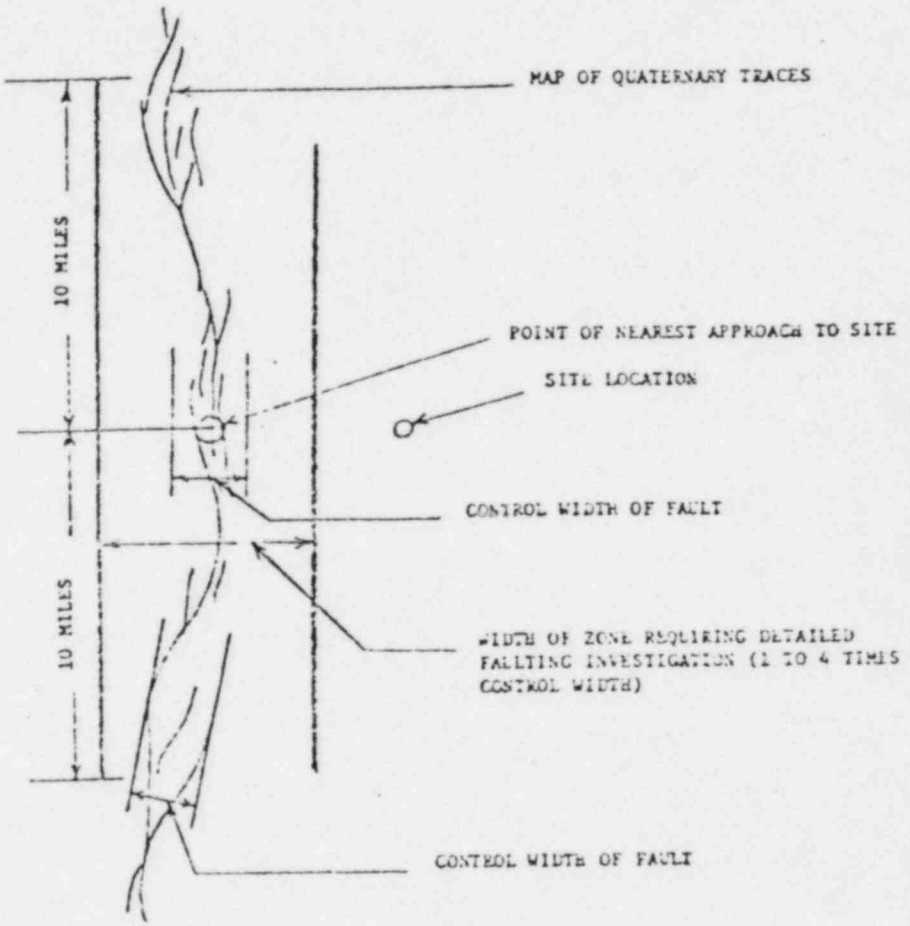

Figure 1 -- Diagrammatic illustration of delineation of width of zone requiring detailed faulting investigation for a specific site area.

Scale 1" = 4 miles

APPENDIX B

DRAFT LETTER TO THE JOINT COMMITTEE ON ATOMIC ENERGY

1. Enclosed for the information of the Joint Committee on Atomic Energy is a notice of proposed rule making to amend the Commission's regulations, 10 CFR Part 100, "Reactor Site Criteria", to add to Part 100 a new appendix, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."

2. The purpose of the proposed amendments is to set forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants and the suitability of the plant design bases established in consideration of the seismic and geologic characteristics of the proposed sites in order to provide reasonable assurance that the nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public.

3. These seismic and geologic criteria would supplement 10 CFR Part 100 by specifying the seismic and geologic investigations and analyses necessary in determining the acceptability of a proposed site, as required by §100.10 of 10 CFR Part 100. Specific references to the proposed Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," would be added to §100.10(c)(1). The provision in §100.10(c)(1) which states that the design of a

facility should conform to accepted building codes or standards and that no facility should be located closer than one-fourth mile from the surface location of a known active earthquake fault would be deleted since these provisions are superseded by the criteria.

4. The notice of proposed rule making will be filed with the Office of the Federal Register and will allow 60 days for public comment after publication in the Federal Register.

5. Enclosed also is a copy of an announcement we plan to issue on this matter in the next few days.

APPENDIX "C"
Draft Public Announcement

AEC PROPOSES TO AMEND REGULATIONS TO PROVIDE SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS

The Atomic Energy Commission is considering the addition of an Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to Part 100 of its regulations under proposed amendments published for public comment today.

The purpose of the proposed amendments is to set forth the principal seismic and geologic considerations used by the Commission in its evaluation of the suitability of proposed sites for nuclear power plants and the suitability of the plant design taking into consideration the seismic and geologic characteristics of the proposed sites.

The criteria were developed in cooperation with the United States Geological Survey and the National Oceanic and Atmospheric Administration. They describe the investigations required to obtain the geologic and seismic data necessary to determine site suitability and to provide reasonable assurance that the nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public.

Information obtained from the investigations will be used to determine the design basis for earthquake-produced vibratory ground motion and for seismically-induced floods and water waves.

Information also will be used to determine whether and to what extent the nuclear power plant need be designed for surface faulting.

All persons who desire to submit written comments or suggestions for consideration in connection with the proposed amendments should send them to the Secretary of the Commission, U. S. Atomic Energy Commission, Washington, D. C. 20545, Attention: Chief, Public Proceedings Branch. Assurance of consideration can be given only if comments are filed within 60 days of publication of the proposed amendments in the Federal Register on _____.